Preface

Optimization in the field of chemical engineering is required to utilize the resources in an efficient way as well as to reduce the environmental impact of a process. Application of optimization processes helps us achieve the most favorable operating conditions. Maximum profit is achievable if a process plant runs at optimum conditions. Knowledge of optimization theory as well its practical application is essential for all engineers.

The idea of this book came to my mind long back, perhaps six years ago. Then I started working on it; selecting topics to be included, collecting research papers, and preparing the manuscript. Many people helped me during this process, especially while collecting research articles from different sources: Sudip Banerjee, Arindam Chatterjee, D.K. Sandilya to name a few. I received very useful suggestions from reviewers of this manuscript.

This book contains detailed theory and applications of optimization in chemical engineering and related fields. Prerequisites for this book include some understanding of chemical engineering, biotechnology and mathematics. This book has been divided into twelve chapters. It contains various classical methods for optimization; it also introduces some of the recently developed topics in optimization. Examples from the field of chemical engineering and biochemical engineering are discussed throughout the book.

Chapter 1 discusses the classification and fundamentals of optimization methods. It also includes the salient features of optimization. This chapter also lists different types of objective functions and conditions for optimization. Chapter 2 gives emphasis to different chemical engineering processes and problem formulation procedures for optimization application. This chapter includes objective function formulation of fluid flow system, heat transfer equipments, mass transfer equipments, and reactors. One dimensional unconstrained problem formulation and optimization have been discussed in Chapter 3. This chapter includes different methods like Newton's method, Quasi-Newton method, Secant method etc. Chapter 4 discusses the Trust-Region methods for both constrained and unconstrained optimization problems. An overview of optimization of multivariable unconstrained functions is given in Chapter 5. This chapter comprises various search methods (i.e. random search, grid search), gradient method, Newton's method etc. Chapter 6 discusses the optimization methods for multivariable functions with constraints. This chapter contains both linear programming and non-linear programming. Optimization of staged and discrete processes has been discussed in Chapter 7. This includes dynamic programming, integer and mixed integer programming. Chapter 8 contains some advanced topics on optimization. This chapter discusses stochastic optimization, multiobjective optimization and optimization problems related to control systems. Most chemical process involve highly nonlinear equations that are difficult to optimize using simple and traditional optimization techniques. Chapter 9 discusses some nontraditional optimization methods like Genetic Algorithm (GA), Particle Swarm optimization, Simulated annealing etc. Chapter 10 elucidates the practical application of optimization theory in various chemical and biochemical processes. Chapter 11 describes different statistical optimization methods. This chapter contains response surface methodology with examples from chemical engineering and biotechnology. Chapter 12 gives an overview of different optimization software tools. This chapter elucidates software for optimization such as LINGO, MATLAB, MINITAB and GAMS. A large number of multiple-choice questions are included at the end of this book. I hope this book will be helpful

for students at undergraduate and graduate levels. Students will benefit if they go through the theories and solved examples side by side.

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Readers of this book are requested to send their comments and suggestions for further improvement.